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Semantically- and Phonologically-Related Primes Improve Name Retrieval in Young and Older Adults

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Abstract

Word and name retrieval failures increase with age, and this study investigated how priming impacts young and older adults' ability to produce proper names. The transmission deficit hypothesis predicts facilitation from related prime names, whereas the blocking and inhibition deficit hypotheses predict interference from related names, especially for older adults. On half of our experimental trials, we exposed participants to a prime name that is phonologically- and semantically-related to a target name. Related names facilitated production of targets overall, with older adults' naming ability improved at least as much as young adults'. Results are contrary to predictions of the blocking and inhibitory deficit hypotheses, and suggest that an activation-based model of memory and language better accounts for retrieval and production of well-known names.

Most individuals have experienced the tip-of-the-tongue (TOT) phenomenon, when they are frustrated by being temporarily unable to access and produce a well-known word. Because TOTs represent a very specific type of problem, in which information is known but currently not available for production, they are often studied as a window into the processes involved in successful word and name production. The present research was designed to increase our understanding of the mechanisms underlying successful name retrieval and TOTs for proper names in young and older adults and to test competing predictions from two theories that are frequently used to explain the TOT phenomenon.

The *blocking hypothesis* suggests that TOTs occur because an alternate word or name (called a blocker under this theoretical orientation) comes to mind while a speaker is trying to produce a target word or name. The blocker actively prevents access to competitor terms, including the target item the individual is trying to retrieve (e.g., Choi & Smith, 2005; Jones, 1989; Schacter, 2001; Schwartz, 2002; Smith & Tindell, 1997). The speaker experiences the blocker coming repeatedly to mind, and has the phenomenological sensation that the blocker is causing the TOT for the intended word. For target retrieval to occur, the individual must suppress the activated blocker, a process implemented via inhibitory or suppression mechanisms, such as those found in several existing models of word retrieval (e.g., O'Seaghdha & Marin, 2000; Valentine, Hollis, & Moore, 1999).

A related model, the *inhibition deficit (ID) hypothesis*, proposes that normal aging disrupts inhibitory mechanisms, reducing the ability to exclude or suppress irrelevant or competing stimuli in a wide variety of contexts (Hasher & Zacks, 1988; Lustig, Hasher, & Zacks, 2007). The frequency of TOT states increases with age (e.g., Burke, MacKay, Worthley, & Wade, 1991; Heine, Ober, & Shenault, 1999; Maylor, 1990), which the ID hypothesis explains as resulting from age-related weakening of inhibitory systems. Older adults activate more incorrect words or names while trying to retrieve a target word, and they are less able

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to suppress these activated competitor words. In other words, older adults demonstrate stronger blocking effects than young adults, with particular difficulty for items that are related to the target word, for example in meaning or in orthography (e.g., Connelly, Hasher, & Zacks, 1991; Logan & Balota, 2003; Zacks & Hasher, 1994). Research to date has provided little support for the blocking model of TOTs or the ID hypothesis as related to age-related increases in TOTs (e.g., James & Burke, 2000; Kornell & Metcalfe, 2006; Meyer & Bock, 1992; Perfect & Hanley, 1992; White & Abrams, 2002). Nevertheless, there have been occasional reports consistent with the blocking/ID explanation[1] (e.g., Jones, 1989; Logan & Balota, 2003), and it maintains strong intuitive appeal with the general public, the popular press, and even cognitive psychologists.

An alternate explanation of TOTs that has gained much more empirical support but less popularity is the *transmission deficit (TD) hypothesis*, which was developed within node structure theory (NST; Burke et al., 1991; MacKay & Burke, 1990). NST is an interactive-activation model with nodes representing meaning (semantic nodes) and nodes representing sounds (phonological nodes), which are connected to each other through a node corresponding to a word or name (a lexical node). In successful word retrieval, a thought activates relevant nodes in the semantic system that transmit priming to enable activation of the desired lexical node, which in turn spreads priming to its connected phonological nodes. All phonological nodes must be activated for production, and a TOT can result when some but not all of a word's phonological nodes are activated (Burke et al., 1991). Within NST, proper names are represented by their own lexical nodes with a slightly modified architectural structure, namely, an additional single connection between the semantics and phonology. This structural difference accounts for the finding that names are more vulnerable to TOTs than other types of words (e.g., Cohen & Burke, 1993; Rastle & Burke, 1996), but within the model, the processes for retrieving and producing proper names do not differ from those used for other types of words (e.g., common nouns, adjectives).

The TD hypothesis proposes that the amount of priming spread through inter-node connections in NST can be reduced due to infrequent or nonrecent use, as well as aging. The TD hypothesis explains that blocker words (called "persistent alternates" within this framework[2]) arise when the correct nodes in the semantic system are activated, along with some phonological nodes that are shared by the target word and the persistent alternate. Alternate words come to mind as a result of failure to access the desired target as opposed to being the direct cause of a TOT. Whereas the blocking/ID approach proposes failed inhibitory processes as the cause of retrieval failures, the TD approach proposes failed excitatory processes as their cause.

In a critical experiment using proper name stimuli, Cross and Burke (2004) tested these two accounts of TOTs. They found that presenting a description of a to-be-named character that an actor had famously played prior to a to-be-named picture of the same target actor (e.g., having participants produce the character name *Eliza Doolittle* before naming a picture of Audrey Hepburn) did not affect name production. The current study utilized procedures similar to Cross and Burke, but aimed to provide the maximum possible opportunity to observe blocking effects in word production. Their test of the blocking hypothesis may not have included competitor terms that were adequately-strong to achieve a blocking effect (i.e., because their names were only semantically related to each other and had no systematic phonological overlap). To ensure that our manipulation provided a very strong test of the blocking hypothesis, we adopted stimuli which seemed most likely to act as potential

[1]We use the phrase "blocking/ID hypothesis" when describing the predictions based on a combination of these theoretical approaches.
[2]We use the term "blocker" when describing the blocking hypothesis but "persistent alternate" when describing the transmission deficit hypothesis in the interest of clarifying the distinct roles of these items under each theoretical approach.

competitors for target names: People with the same first name and who are famous within the same domain of work were presented prior to a target celebrity. Thus, our prime names were semantically related to our target names (which we verified with participant ratings) and they were also phonologically and orthographically related (with identical first names). Like Cross and Burke, we used proper noun stimuli as both primes and targets. This conferred two benefits. First, proper names suffer from a higher rate of retrieval failures than other types of words, especially for older adults (e.g., James, 2006), increasing our ability to detect fluctuations in TOT rates across conditions. Second, the primes and targets were from the same grammatical class, an important factor in obtaining interference effects (Abrams, Trunk, & Merrill, 2007). Also, similarly to Cross and Burke, we tested older adult participants, because the blocking/ID hypothesis suggests they are more susceptible to blocking than young adults. Additionally, we adopted primes that shared not only meaning with the targets, but also orthography and phonology, because Logan and Balota (2003) found blocking effects that increased with age on a word retrieval task following presentation of orthographically-related competitor terms. In NST, orthographic and phonological nodes are linked laterally (e.g., MacKay & Abrams, 1999) and thus items with orthographic overlap will also have overlapping phonology. These features of our experiment were intended to maximize the opportunity to achieve evidence for blocking effects.

The present study was designed to provide the strongest possible test of predictions from two competing theories. The ID/blocking hypothesis proposes that TOTs occur because blockers come to mind and suppress retrieval of the target word or name, and that this inability to overcome blockers is a particular problem for older compared to young adults. The TD hypothesis proposes that TOTs result from weakened transmission of excitation through connections in the language system, and that this weakening is a particular problem for older compared to young adults. The dependent variables measured to test these theories were correct retrievals and TOTs, selected because of their inverse relationship to each other in both of these theoretical accounts. Under both approaches, a TOT occurs when a known item is temporarily inaccessible. When the temporary inaccessibility is overcome, the TOT is resolved and retrieval of the correct item occurs.

Both the blocking/ID and TD hypotheses predict that older adults will have more TOTs and a corresponding decrease in correct responses than young adults. However, the blocking/ID explanation attributes the age difference to decreased inhibition in aging, leading to reduced suppression of blockers, whereas the TD explanation attributes it to decreased connection strength in aging, leading to failure to retrieve the complete phonology of the target.

The blocking hypothesis predicts that related prime names will increase TOTs and decrease correct retrievals for target names, because they will act as competitors and interfere with retrieval of the target. According to the blocking/ID hypothesis (i.e., the predictions from a combination of the blocking and ID hypotheses), because older adults have more difficulty inhibiting alternates than do young adults, target production following a related prime name will be even more harmed for older than young adults. In other words, older adults will experience the blocking effect more strongly than young adults, yielding an interaction between age group and prime condition.

The TD hypothesis predicts that related prime names will increase correct retrievals and decrease the occurrence of TOTs for target names, by strengthening the connections among all relevant nodes and allowing better access to the target’s phonology. According to the TD hypothesis, because older adults have weaker connections than young adults, target production following a related name prime will be facilitated to at least the same extent for older as young adults. In other words, older adults will benefit from the related primes as much as or more than young adults. This could yield no interaction between age group and prime condition (if the benefit is identical in magnitude for young and older adults) or an interaction such that older adults benefit more from a related prime than young adults – an interaction opposite that predicted by the blocking/ID hypothesis.

Method

Participants

Participants were 29 young adults (age range: 18–27 years; $M = 20.34$, $SD = 2.14$) and 26 healthy older adults (age range: 55–86 years; $M = 68.54$, $SD = 6.81$). Young adults were students given course credit for participation. Older adults were independently-living individuals who expressed interest in participating in research, and were required to have scored at least 25 correct (out of 30 possible) on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) within the previous 6 months in order to be recruited for the study, and were compensated $15. Participants were required to have lived in the United States of America for at least 10 years. On average, young adults had fewer years of education ($M = 13.86$, $SD = 1.46$) than older adults ($M = 15.27$, $SD = 1.89$), $t(53) = 3.11$, $p = .003$, and lower scores on the Shipley vocabulary test ($M = 28.48$, $SD = 3.31$) than older adults ($M = 35.23$, $SD = 4.08$), $t(53) = 6.76$, $p < .001$. Older adults' ($M = 49.19$, $SD = 6.23$) and young adults' ($M = 46.90$, $SD = 3.63$) number correct on the Media Savvy Test did not differ, $t(53) = 1.69$, $p = .10$.

Materials

Selection of experimental stimuli initially involved showing 110 celebrity photographs to 8 adults of various ages, none of whom later participated in the main experiment. Participants indicated whether they knew the celebrity's name, did not know it, or were having a TOT. They also indicated whether they thought each picture accurately portrayed the celebrity and rated how familiar they were with the celebrity from 1 (*not at all*) to 5 (*extremely*). Participants were encouraged to provide any additional comments they had about the stimulus pictures. This pilot testing narrowed down the stimulus pool to 40 target celebrities who were determined to be recognizable and famous. For each target, a definition was created to elicit the name of a celebrity who shared semantic information and whose name had phonological overlap with the target (see Appendix A). Although it is very difficult to precisely equate stimulus familiarity across generations, the pilot testing ensured that most targets would be known by participants from both age groups (see also the ratings tasks completed by our experimental participants, below).

These 40 targets were divided into Set 1 (with 20 targets preceded by a related prime and the other 20 by an unrelated celebrity name) and Set 2 (with relatedness counterbalanced across targets). Following the procedure of Burke, Locantore, Austin, and Chae (2004) and Cross and Burke (2004), all target celebrities in the naming task were pictured, while primes were presented as celebrity descriptions with the first initial of their first and last names included as cues (see Figure 1). The use of descriptions, which provide more detailed information than photos, and letter cues increased the probability that participants would correctly produce the intended prime name. Even though participants were always shown the correct prime name, we wanted to control for the possibility that participants could make an error (i.e., produce an incorrect name) prior to viewing the correct prime name, because the erroneous name could be semantically- or phonologically-related to the target, thus impacting the priming effect. Additionally, the procedure of alternating photographs and descriptions helped disguise the true purpose of the experiment (i.e., participants were told the study compared the ability to name celebrities based on their photographs versus descriptions, in order to reduce awareness of the priming manipulation).

Participants were provided with instructions (including a definition of a TOT), and were shown all stimuli on a PowerPoint slideshow. Participants received hard-copy response sheets with spaces to write a celebrity name when known, or to indicate that they did not know or were having a TOT for a name. Task instructions and the TOT definition were also written on this form. There was also a space where participants were to confirm whether the target's name was in fact the name for which they were experiencing a TOT.

Additional materials included two ratings forms that participants completed following the experiment. The first listed all target names and participants rated each celebrity on how famous they perceived them to be on a scale from 0 (*not famous*) to 5 (*very famous*). The other form presented each target celebrity name with his or her related prime. Participants rated the pairs on how similar they perceived them to be based on the type of work for which they are famous on a scale from 0 (*not similar*) to 5 (*very similar*). They were instructed to check a box labeled *Don't Know* whenever they did not know one or both of the celebrities in the pair. In other words, they only provided a rating when they were familiar with both celebrities in the pair. All participants rated all targets and their related prime (i.e., not only rating the similarity of the items they saw in the related prime condition, but also those they saw in the unrelated condition).

Participants completed a modified version of the Media Savvy Test (Cross & Burke, 2004) as a measure of their general familiarity with popular media. The original test contains 18 real movie and 18 real television show titles, and 36 fabricated show titles. We changed six real items to more recent titles and eliminated two items, resulting in 70 total items (see Appendix B). Participants indicated whether each title represented a real show or movie, and their score was the number correct. Participants also completed the Shipley Vocabulary Test (Shipley, 1940), an informed consent form, and a demographics form.

Procedure

Participants were told that the study would examine young and older adults' ability to name celebrities based on either photos or descriptions of them. One to four participants from the same age group were tested as a group in a research room at the university. Each group was randomly assigned to view Set 1 or Set 2 of the stimuli. Participants read and signed the consent form, then were provided with a packet of materials starting with the response sheet for the main task. They viewed the PowerPoint slide show, starting with instructions and a practice trial consisting of two pictures and two descriptions of celebrities. They then had the opportunity to ask for clarification prior to the start of the main task.

When participants saw a celebrity description, a sentence containing the work they are known for was presented for 12 s, along with the first letter of their first and last names. The name was then added to the slide (replacing the cue letters) for 6 s to ensure that all participants were exposed to the prime name. Pictures were shown on a slide (without letter cues) for 12 s; the name was then added to the slide for 6 s for symmetry with the prime slides.

Figure 1 presents an example of the sequence of stimulus slides as presented to participants. For the target *Tom Hanks* in the related prime condition (slide 4), participants named a description of a celebrity with the same first name and known for similar work as the target (*Tom Cruise*; slide 1). A filler celebrity photo (*Barbara Walters*; slide 2), and a filler celebrity description (*Al Pacino*; slide 3), came between the prime and target to obscure the relationship between them. For the target *John Travolta* in the unrelated prime condition (slide 8), participants named a description of an unrelated celebrity (*Anne Hathaway*; slide 5), with a filler celebrity photo (*Oprah Winfrey*; slide 6), and a filler celebrity description (*Charlize Theron*; slide 7) between the prime and target. The sequence of slides did not indicate to participants that there were related and unrelated conditions, or that there were prime/target pairs. The participant experienced the slides as a continuous sequence of alternating photographs and definitions to name. Answers were added onto each slide following participants' responses (i.e., they were not initially presented on the slide).

For each description or photo, participants circled that they knew, did not know, or were having a TOT for the celebrity's name, and they wrote the name if they knew it. Participants were informed that they could change a *TOT* response to a *Know* response if the name was correctly retrieved before the correct name was presented. They were also permitted to change a *Know* response to a *TOT* if they initially reported knowing the individual's name, but were unable to produce it, if in a manner consistent with the provided definition of a TOT. After the 12 s during which the stimulus was presented, the name of the individual was displayed and read aloud to ensure that participants were exposed to the related prime name. For *Know* and *TOT* responses, they were then asked to indicate if this was in fact the person they named or whose name they were searching for. It should be noted that participants could have written in the correct name of targets in the 6 s during which it was being presented when they were actually unable to produce it on their own. However, it was explicitly stated during the instructions that they were not to write in any target names after presentation. Additionally, testing groups were small and each participant was visible to the experimenter at all times to allow monitoring, ensuring that this did not occur.

After the entire set of stimuli was presented, participants answered two questions to assess their awareness of the purpose of the study and their awareness of priming. First they were instructed to write what they thought we were studying. The second question asked if they noticed that some celebrities were preceded by picture of a related person and they were to describe any relationship they thought might be present.

Participants then completed ratings forms to assess how familiar they perceived each celebrity to be and how similar they thought the related primes and targets were to one another. Participants also completed the Media Savvy Test, followed by the Shipley vocabulary measure and a brief demographics questionnaire. A debriefing statement explaining the task and true purpose of the experiment was read and opportunity for questions was provided. The experiment took between 1–1.5 hr.

Results

Ratings of each target's perceived fame were calculated as an average of all targets evaluated (i.e., excluding items that a participant skipped for unknown reasons). Older (M = 3.31, SD = 1.00) and young (M = 3.52, SD = 0.67) adults did not differ on average fame ratings, $t(53) = 0.93$, $p = .34$. Ratings of each target's perceived similarity to its related prime were also calculated as an average of all prime/target pairs evaluated, excluding those that were marked *Don't Know* due to the participant's lack of knowledge about one or both of the celebrities in the pair. Older adults (M = 3.76, SD = 1.21) rated celebrity pairs to be more similar than young adults (M = 2.86, SD = 0.97), $t(53) = 3.06$, $p = .003$.

For the naming task, *Know* responses were scored when participants circled *Know* and correctly wrote the target celebrity name. *Incorrect Know* responses were scored when participants circled *Know,* but then answered *no* when asked if the target was the person they were thinking of, or wrote an incorrect name. Responses were scored as *TOT*s when participants circled *TOT* and indicated that the target was the person they were thinking of. If they indicated that they were not thinking of the target person, that response was scored as an *Incorrect TOT*. *Incorrect Know* and *Incorrect TOT* responses were rare for participants in both age groups (fewer than 3% of responses in each category) and did not differ by age or between related and unrelated prime conditions, all *p*s > .09. *Don't Know* responses were not analyzed because they represent a variety of types of errors (e.g., visual identification problems, lack of familiarity with the celebrity, etc.; see James, 2006) and not necessarily failures to retrieve known names.

A 2 (age group: young vs. older adults) × 2 (prime condition: related vs. unrelated) mixed factorial analysis of variance (ANOVA) was used to analyze the percent of trials with *Know* responses (see Table 1 and Figure 2). There were more correct responses in the related than unrelated condition, $F(1, 53) = 22.37$, $\eta_p^2 = .30$, $p < .001$, and more correct responses for young than older adults, $F(1, 53) = 3.97$, $\eta_p^2 = .07$, $p = .05$. The interaction between prime condition and age group was not significant, $F(1, 53) = 2.75$, $\eta_p^2 = .05$, $p = .10$, indicating that prime condition did not differently influence young and older adults' correct responses. Follow up tests were conducted in spite of the non-significant result to test for the interaction predicted by each theory. Young adults produced marginally more correct responses in the related than unrelated condition, $t(28) = 1.88$, $p = .07$, and this benefit of relatedness was significant and numerically larger for older adults, $t(25) = 5.98$, $p < .001$.

A second 2 (age group: young vs. older adults) × 2 (prime condition: related vs. unrelated) mixed ANOVA was used to analyze the percent of *TOT* responses (see Table 1 and Figure 2). Participants reported fewer *TOT*s in the related than unrelated condition, $F(1, 53) = 37.47$, $\eta_p^2 = .41$, $p < .001$, but there was no main effect of age, $F(1, 53) = 1.70$, $\eta_p^2 = .03$, $p = .20$. However, prime condition interacted with age group, $F(1, 53) = 4.51$, $\eta_p^2 = .08$, $p = .04$, indicating that young and older adults' *TOT* responses were differentially influenced by the prime conditions. However, within-group comparisons of priming indicated that both young adults, $t(28) = 3.43$, $p = .002$, and older adults, $t(25) = 4.95$, $p < .001$, had fewer *TOT* responses in the related than unrelated condition.

Following analysis of participants' responses for all targets, data were reanalyzed using conditionalized scoring of each participant's *TOT* and *Know* responses. For each participant, targets in the related condition which a participant rated as not being similar to their prime (similarity ratings of 0 or 1, or marking the *Don't Know* box), and targets which they did not perceive to be famous (fame ratings of 0 or 1) were eliminated from their total number of trials. This allowed examination of results for only those targets that were ideal stimuli for each participant. As with original data, conditionalized *Know* and *TOT* scores were calculated as a percentage of trials, and data were only analyzed for those participants retaining 20 percent of the targets (i.e., at least four of the 20 targets in the unrelated condition were rated as famous, and four of the 20 targets in the related condition were rated as famous and similar to their prime). Additionally, participants who reported 5% or fewer *TOT* responses were excluded. These requirements eliminated three young adults and five older adults from analyses.

A 2 (age group: young vs. older adults) × 2 (prime condition: related vs. unrelated) mixed ANOVA was used to analyze the percent of conditionalized *Know* responses (see Table 1). There were more correct responses in the related than unrelated condition, $F(1, 45) = 32.16$, $\eta_p^2 = .42$, $p < .001$, with a numerically-larger difference than in the initial analysis. There was a marginally-significant effect of age, $F(1, 45) = 3.06$, $\eta_p^2 = .06$, $p = .09$, that was numerically-smaller than in the initial analysis. The interaction between prime condition and age group was not significant, $F(1, 45) = 0.49$, $\eta_p^2 = .01$, $p = .49$, as in the initial analysis, and follow-up tests indicated significant priming effects for both young, $t(25) = 3.38$, $p = .002$, and older adults, $t(20) = 4.99$, $p < .001$.

A final 2 (age group: young vs. older adults) × 2 (prime condition: related vs. unrelated) mixed ANOVA was used to analyze the percent of conditionalized *TOT* responses (see

Table 1). Participants reported fewer *TOT*s in the related than unrelated condition, $F(1, 45) = 23.43$, $\eta_p^2 = .34$, $p < .001$, and older adults reported marginally more TOTs than young adults, $F(1, 45) = 3.33$, $\eta_p^2 = .07$, $p = .08$. The interaction between prime condition and age group approached significance, $F(1, 45) = 2.85$, $\eta_p^2 = .06$, $p = .10$, with follow-up tests indicating significant priming effects for both young, $t(25) = 2.65$, $p = .01$, and older adults, $t(20) = 3.91$, $p = .001$.

Discussion

Both the original and conditionalized analyses indicated a helpful rather than harmful effect of related primes on target naming. Specifically, prior presentation of related prime names reduced TOTs and increased correct responses compared to unrelated prime names, supporting predictions of the TD hypothesis and contradicting the blocking hypothesis. We obtained these results despite our design of an experiment with optimal opportunity for participants to experience blocking from related primes: Our primes overlapped the targets in grammatical class, semantics, orthography, and phonology. Further, we tested older adult participants, who have been shown to be particularly susceptible to interference, possibly due to inhibitory deficits, on a wide range of experimental tasks (e.g., Anderson, Reinholz, Kuhl, & Mayr, 2011; Logan & Balota, 2003; Malmstrom & LaVoie, 2002; Mund, Bell, & Buchner, 2010). The present study joins several other experiments in failing to support blocking effects in word and name retrieval studies, whether the blockers were meant to create semantic competition (e.g., Cross & Burke, 2004; Vitkovitch, Potton, Bakogianni, & Kinch, 2006) or phonological competition (e.g., James & Burke, 2000; White & Abrams, 2002; but see Abrams et al., 2007). As suggested by Logan and Balota (2003), we increased the degree of overlap between competitor terms and targets from that employed in previous research, and still failed to obtain blocking effects.

Both young and older adults evidenced benefits of related prime names on correct responses. However, there was a significant interaction (in the original analysis) and a marginal interaction (in the conditionalized data analysis) between aging and prime condition on TOT responses, indicating that older adults' TOTs were reduced more than young adults' following presentation of related prime names. These patterns again support predictions made by the TD hypothesis, and are contrary to those of the blocking/ID hypothesis.

Young adults had more correct retrievals overall than older adults, a finding predicted by both theoretical approaches. The blocking/ID hypothesis explains older adults' difficulties as resulting from a reduced ability to ignore or suppress blockers, preventing retrieval of the target item. The TD hypothesis explains older adults' difficulties as a consequence of weakened connections between the lexical node for the name and the phonological nodes. This age difference is consistent with previous findings that young adults provide more correct answers than older adults in proper name production tasks (Burke et al., 2004; Cross & Burke, 2004; Maylor, 1990). However, many previous studies have identified higher rates of TOTs for older than young adults, especially when naming famous people (e.g., Burke et al., 1991; 2004; Cross & Burke, 2004; Evrard, 2002; James, 2006; Rendell, Castel, & Craik, 2005), which we did not find in our original analysis and was only marginally significant in our analysis of the conditionalized data. The non-significant effect of age on TOTs was unexpected under both theoretical approaches, but, more importantly, we did obtain the interaction between prime condition and age on TOT rate that was predicted under the TD approach.

Our conditionalized data included only targets that were: 1) rated by the participant to be well-known; 2) paired with a semantically and phonologically related prime name they also knew; and 3) judged by each participant to be similar to the target. This aspect of our analysis ensured that the results were not due to generational differences in familiarity with the prime or target celebrities. While some targets were likely more familiar to members of one age group or the other, young and older participants rated the overall average fame of the targets to be similar. Although these results indicate that the targets themselves were appropriate stimuli, older adults did rate the prime/target pairs as more similar than the young adults did, suggesting that young adults made more finely-distinguished assessments of similarity. However, older adults' greater similarity ratings mean that that the prime names should have been even stronger potential competitors for older than young adults, yet older adults did not demonstrate any hint of interference. Further, this age difference in similarity ratings was addressed with the conditionalized data analysis, which yielded similar patterns to the original analysis. Finally, the two age groups' scores on the Media Savvy Test indicate that they did not differ on their prior general familiarity with popular media. In sum, age differences in factors related to the experimental stimuli cannot be the cause of the obtained patterns of results.

The current design did not encourage or permit strategic use of related primes to deduce and produce the correct target names. The inclusion of filler descriptions and photos disguised the purpose of the experiment, and provided separation of primes and targets across time. The fixed pace at which participants were presented each stimulus limited their ability to reflect on previous stimuli. Participants' responses on the follow-up questions about the purpose of the study indicated that they believed our cover story (that we were studying differences in young and older adults' abilities to name celebrities based on either photos or descriptions). When participants indicated that they thought we were studying something else, they typically reported thinking that we were interested in age differences in memory, overall knowledge of celebrities, or general production of TOTs. When directly asked if they noticed that some celebrities were preceded by a related individual, only one young adult participant reported that some celebrities had the same name. Almost all participants said that they did not notice, and those who did report noticing a connection described some celebrities as having worked together (e.g., Courtney Cox preceded David Schwimmer, and both were in *Friends*), or having a personal link between them (e.g., Angelina Jolie preceded Brad Pitt, to whom she is married).

It remains possible that we did not present adequately strong competitor names. For example, perhaps blockers are personally "tailored," such that for any one speaker, only specific words can block retrieval of a given target. However, Kornell and Metcalfe (2006) presented each participant's self-generated persistent alternate term prior to a second retrieval attempt, and still did not obtain blocking effects. Nevertheless, they were testing TOT resolution and not the causes of TOTs, so further work using self-generated alternates could prove informative.

Overall, results of the current study support the TD hypothesis. The beneficial effect of related prime names on subsequent target production for young and older adults indicates that the strengthening of weakened inter-node connections facilitates production. These results are particularly damaging to the blocking hypothesis. We selected highly-related prime names that overlapped the target in grammatical class, semantics, orthography, and phonology, yet these probable-competitor names did not increase TOTs or decrease correct retrievals, even among older adults, a group expected to be more vulnerable to blocking effects. As Kornell and Metcalfe (2006) clearly articulated, "Occasionally a mistaken belief becomes ingrained in researchers' collective understanding. Blocked TOTs appear to be such a case" (p. 259). The vast majority of empirical evidence to date suggests that an activation-based model of memory and language better accounts for retrieval and production of well-known words and names than an inhibitory or blocking approach.

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Appendix A: List of Stimuli

Target	Related Prime	Unrelated Prime
Ben Affleck	Ben Stiller	Christina Applegate
Joe Namath	Joe Montana	Christina Applegate
Tim Allen	Tim Robbins	Michelle Pfeiffer
Paul Rudd	Paul Walker	Michelle Pfeiffer
Adam Sandler	Adam Brody	Bruce Willis
Chris Rock	Chris Tucker	Bruce Willis
Julia Roberts	Julia Stiles	Meg Ryan
Sarah Jessica Parker	Sarah Michelle Gellar	Meg Ryan
Tom Hanks	Tom Cruise	Nicholas Cage
Will Ferrell	Will Smith	Nicholas Cage
Hillary Swank	Hilary Duff	Mark Wahlberg
Jennifer Garner	Jennifer Anniston	Mark Wahlberg
Bill Murray	Bill Cosby	Samuel L Jackson
Christopher Walken	Christopher Reeve	Samuel L Jackson
Jessica Biel	Jessica Alba	Tyra Banks
Kate Winslet	Kate Hudson	Tyra Banks
John Travolta	John Cusack	Anne Hathaway
Steve Martin	Steve Carrell	Anne Hathaway
Matthew McConaughey	Matthew Perry	Joaquin Phoenix
Drew Brees	Drew Bledsoe	Joaquin Phoenix
Susan Sarandon	Susan Lucci	Ashton Kutcher
Eva Longoria-Parker	Eva Mendes	Ashton Kutcher
Christian Bale	Christian Slater	Jackie Robinson
David Schwimmer	David Duchovny	Jackie Robinson
Hugh Grant	Hugh Jackman	Russell Crowe
Jack Nicholson	Jack Palance	Russell Crowe
Kevin Costner	Kevin Bacon	Heath Ledger
Richard Gere	Richard Dreyfuss	Heath Ledger
Michael J. Fox	Michael Keaton	Alec Baldwin
Woody Harrelson	Woody Allen	Alec Baldwin
Colin Farrell	Colin Firth	Brad Pitt
Heather Locklear	Heather Graham	Brad Pitt
James Dean	James Caan	Scarlett Johansson
Anthony Hopkins	Anthony Quinn	Scarlett Johansson
Martin Short	Martin Lawrence	Katherine Heigl

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Target	Related Prime	Unrelated Prime
William Shatner	William H Macy	Katherine Heigl
Matt Damon	Matt Dillon	Demi Moore
Troy Polamalu	Troy Aikman	Demi Moore
Jeff Bridges	Jeff Goldblum	Mel Gibson
Robert Duvall	Robert Redford	Mel Gibson

Appendix B: Modified Media Savvy Test

Title	Real or Fake	
1. Horse Sense	Real	Fake
2. The Mat	Real	Fake
3. Elephant	Real	Fake
4. In the Wild	Real	Fake
5. Crime Watch	Real	Fake
6. Spin City	Real	Fake
7. Home Improvement	Real	Fake
8. Free and Clear	Real	Fake
9. Party of Five	Real	Fake
10. 7th Heaven	Real	Fake
11. Cool Off	Real	Fake
12. As Good As It Gets	Real	Fake
13. In the Public Eye	Real	Fake
14. Mordant Observations	Real	Fake
15. Nightline	Real	Fake
16. The X-Files	Real	Fake
17. Act Naturally	Real	Fake
18. Blue Jay Way	Real	Fake
19. Sutton Place	Real	Fake
20. Wild Roses	Real	Fake
21. Harper Woods	Real	Fake
22. Dynasty	Real	Fake
23. Hacking It	Real	Fake
24. Friends	Real	Fake
25. Empire Records	Real	Fake
26. Dive Quest	Real	Fake
27. Fantasy Island	Real	Fake
28. Side By Side	Real	Fake
29. The Sound of Music	Real	Fake
30. Hello, Goodbye	Real	Fake
31. Breaking Even	Real	Fake
32. A Day in the Life	Real	Fake

Title	Real or Fake	
33. Talon's Song	Real	Fake
34. Tolstoy's Dream	Real	Fake
35. Picket Fences	Real	Fake
36. The Clash of the Titans	Real	Fake
37. Days Gone By	Real	Fake
38. Driving Miss Daisy	Real	Fake
39. Boston Public	Real	Fake
40. Our Neighborhood	Real	Fake
41. On the Town	Real	Fake
42. Havoc	Real	Fake
43. Alien Scientist	Real	Fake
44. The Highlander	Real	Fake
45. French Fryes	Real	Fake
46. Out of Tibet	Real	Fake
47. The Adventurists	Real	Fake
48. The Way We Were	Real	Fake
49. The Beverly Hillbillies	Real	Fake
50. Code Blue	Real	Fake
51. The Odd Couple	Real	Fake
52. The Drew Carey Show	Real	Fake
53. Saving Private Ryan	Real	Fake
54. Spilt Milk	Real	Fake
55. Access Hollywood	Real	Fake
56. The Nice Guy	Real	Fake
57. Air Force One	Real	Fake
58. The Joy Luck Club	Real	Fake
59. The Last Boyscout	Real	Fake
60. The Color Purple	Real	Fake
61. Family Ties	Real	Fake
62. The Woodsman	Real	Fake
63. Girl Talk	Real	Fake
64. Dallas	Real	Fake
65. Unspeakable Contrivances	Real	Fake
66. Flatliners	Real	Fake
67. Joyride	Real	Fake
68. Groove Street	Real	Fake
69. Summer's Over	Real	Fake
70. Remains of the Day	Real	Fake

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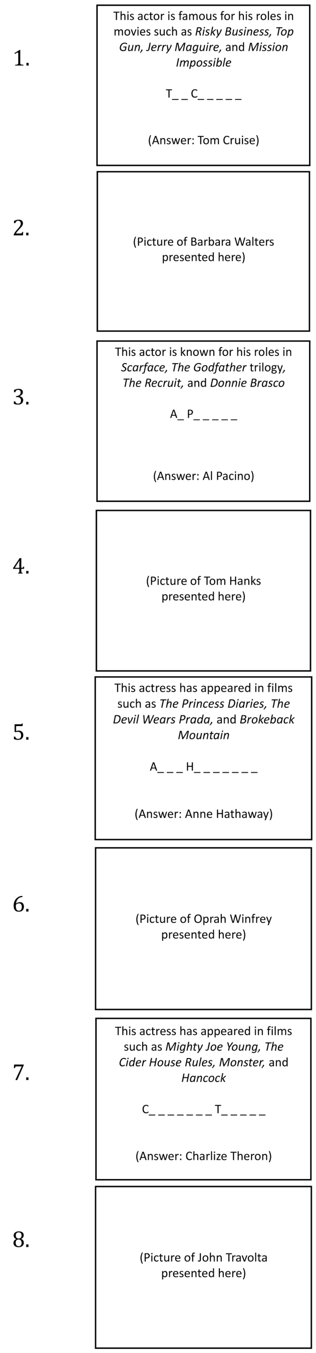

Figure 1.

Example sequence of stimulus slides as seen by participants (answers were not presented on the slides until after participants had responded). In this example, slide 1 was a related prime for the target slide 4, and slide 5 was an unrelated prime for the target slide 8. Slides 2, 3, 6, and 7 were filler items.

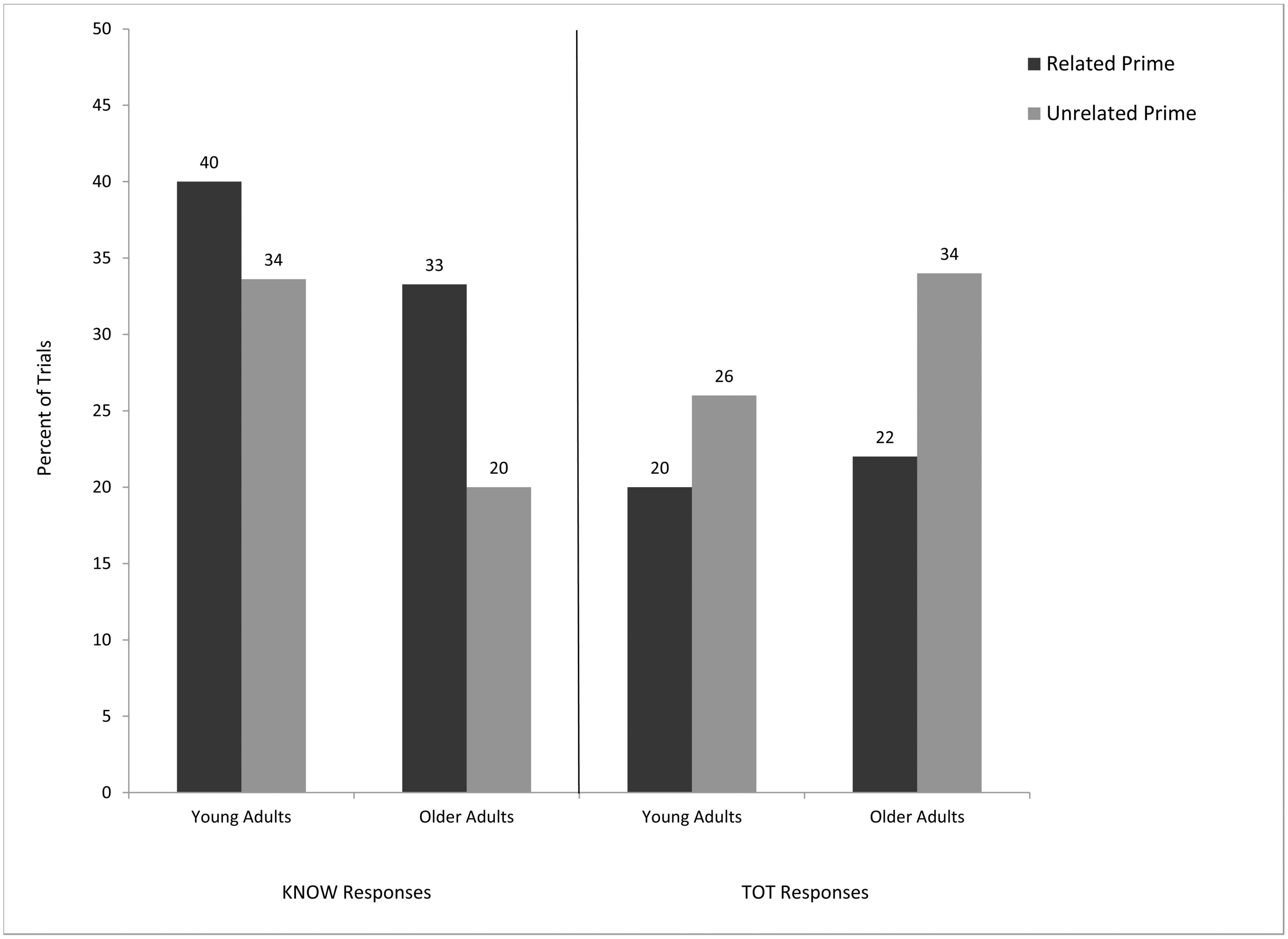

Figure 2.

Percent of trials with Know and TOT responses for young and older adults in the related and unrelated primed conditions (using original data scoring).

Table 1

Mean percent of trials with *Know* and *TOT* responses for Analyses of the Original (top panel) and Conditionalized (bottom panel) Data Sets (SE in parentheses).

Original Analysis	**Young (n = 29)**	**Older (n = 26)**
Know Responses		
Primed	40% (4%)	33% (4%)
Unprimed	34% (3%)	20% (4%)
TOT Responses		
Primed	20% (3%)	22% (3%)
Unprimed	26% (3%)	34% (3%)
Conditionalized Analysis	Young (n = 26)	Older (n = 21)
Know Responses		
Primed	53% (5%)	45% (5%)
Unprimed	40% (4%)	28% (4%)
TOT Responses		
Primed	25% (4%)	30% (4%)
Unprimed	32% (4%)	45% (4%)

Note: Don’t Know, Incorrect Know, and Incorrect TOT responses comprised the remaining data but were not analyzed and are not included in this table.